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Pakistan: energy development and economic growth in the 1980s

Robert E. Looney

FOR SOME TIME, economists have argued that a variety of factors can obstruct a rapid pace of economic development.[1] Scarcities of capital, a skilled and disciplined labour force, entrepreneurial talent, foreign exchange and industrial raw materials have been mentioned, among the prominent obstacles to growth in undeveloped countries. Lack of adequate energy supply is now being added as a factor explaining the slow pace of growth in these countries. For a large number of less developed countries have to depend on imported sources of energy; the high foreign exchange bills, resulting from rapidly rising prices, are simply beyond their means. Pakistan is a good case in point.

The purpose of this paper is to examine whether investment in energy and increased domestic production of energy increased the rate of economic growth in Pakistan during the 1980s. The analysis that follows focuses on the following two questions.

(a) (through the use of comparative cross-sectional data) How did Pakistan compare with other countries in its energy efforts and what were the consequences of this for growth in the 1980s?

(b) Did energy investment in Pakistan initiate an expansion in the country's economy or was it simply a response to the need created by that growth?

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Background

There is rapidly expanding anecdotal literature describing the problems associated with energy shortages in Pakistan.[2] In fact, the 1980s witnessed a major increase in the frequency and intensity of power outages, especially in the industrial sector. These outages appeared to be localised in two provinces: the Punjab and the North-West Frontier Province (NWFP). This led to complaints, by the various chambers of commerce and industry and other industrial associations in the country, that the level of production in a number of industries had been reduced by a factor of about a quarter to a third, due to the persistence of outages that apparently had fundamentally disturbed the normal rhythm of the production cycle in a large number of industrial units.

Writing in 1981, Ebinger[3] noted:

> Pakistan exemplifies the energy policy-planning dilemma. Despite considerable opportunities, the nation has failed to develop the power-generating capability that could alleviate its most pressing energy problems. The failure to achieve success has been costly: industrial output has remained low and agricultural growth, while improving during 1979–80, has, in general, failed to keep pace with the growth of population. Failure to bring electric power to large areas of the countryside has led to an increased reliance on non-fossil fuels (wood bagasse, cotton sticks, dung), with serious damage to the environment: the rapid increase in the siltation rate in the Indus and Kabul Rivers is but one example. Finally, the continued lack of electric power distribution in Baluchistan and the North-West Frontier Province has exacerbated long-standing economic grievances against the Sindhi and Punjabi industrial and agricultural elites and has increased the already pronounced separatist tendencies of these two provinces, with potentially serious effects on the national integration of Pakistan.

Infrastructural constraints, especially in electric power generation and transport, have remained a major factor preventing the manufacturing sector from attaining its full potential in the economy. While transport facilities have remained poor and inadequate, energy supplies have also fallen short of demand. One study[4] found that, while outage costs in the industrial sector were not as high as claimed by some industrial associations in the country, they were still large enough (about 1.8 per cent of gross domestic product) to warrant an expanded programme of investment in energy generation in the medium run and the pursuit of a loss-minimising load management strategy and pricing policy in the short run.

Energy consumption levels in Pakistan have been much lower, even relative to other less developed countries. Thus, while the average per capita consumption of oil equivalent commercial energy in low-income economies was 322 kg in 1988, it was 210 kg in Pakistan (the corresponding levels in Bangladesh, India and Sri Lanka were 50, 211 and 162 respectively).[5]

Limited public funds for development in the country have also created a dichotomy in both transport and energy, with modern transport modes and dependence on commercial energy in urban areas (including industrial townships) coexisting with extensive use of traditional fuels and vehicles in villages and backward locations. At the same time, given the high rates of population growth, pressures on existing infrastructural facilities have been emerging rapidly. Augmentation of supply of traditional forms has only been possible at a slow pace. On the other hand, for commercial urban utilities, the lack of internal generation of resources has hampered self-sustaining expansion. Another conspicuous feature common to Pakistan and the other South Asian countries has been their high dependence on crude oil and petroleum imports.[6]

In Pakistan, commercial energy consumption, by decreasing order of importance, is oil (40 per cent), gas (33 per cent), hydroelectricity (22 per cent) and nuclear (five per cent). Existing development plans have addressed the problem of inadequate energy availability, and the strategic approach to this sector includes:[7]

1. an intensification of the search for fresh indigenous sources;
2. the development of nuclear energy;
3. arranging inter-fuel adjustments;
4. intervention through market forces, by altering relative energy prices; and
5. encouraging participation by the private sector, as well as foreign investors.

Pakistan's commercially exploitable energy resources consist of hydropower, natural gas, oil and coal. Despite the country's good endowment of energy resources, its dependence on energy imports (crude oil and oil products) has been increasing because of under-utilisation of domestic resources. At the same time, as noted above, energy shortages (mainly power) have continued. During the last decade, the Fifth and Sixth Plans targets emphasised the accelerated development of domestic energy resources, but financial and implementation constraints impeded the achievement of these targets. New targets for the next 20 years (to the year 2010) were set in the Long-Term Energy Strategy (LES) prepared in the late 1980s, but implementation of this new set of targets is already behind schedule. This is due to the limited availability of funds for public investment and, most importantly, because the expected increase in private sector investment has not taken place.

Shortages in hydropower generation have led to a more rapid development of thermal generation capacity. The latter has lower investment costs and shorter gestation periods, but results in higher operational costs and increased pressure on the

Table 1
Developing countries: major structural and performance patterns
factor loadings

Variable	Factor 1 Growth 1970s	Factor 2 Growth 1980s	Factor 3 Public/debt expenditure	Factor 4 Size
Investment growth 70–80	0.90*	0.07	–0.11	0.05
Import growth 65–80	0.90*	–0.05	0.06	0.08
GDP growth 70–80	0.86*	0.25	–0.01	–0.04
Energy consumption growth 65–80	0.78*	–0.15	0.06	–0.03
Share of investment in GDP 1980	0.67*	–0.01	0.45	0.03
Public consumption growth 70–80	0.66*	–0.12	0.39	0.09
Energy consumption growth 80–88	0.62*	0.44	–0.19	0.11
Agriculture growth 70–80	0.47	0.25	–0.21	–0.14
Investment growth 80–88	–0.20	0.83*	–0.05	–0.03
GDP growth 80–88	0.32	0.80*	–0.01	0.08
Import growth 80–88	–0.24	0.77*	0.09	–0.11
Public consumption growth	0.09	0.61*	–0.09	0.21
Investment/GDP 88	0.26	0.46	0.38	0.10
Debt/GDP 88	–0.27	–0.44	0.31	–0.25
Debt service/GDP 88	0.15	–0.01	0.80*	–0.14
Exports/GDP 88	0.02	0.19	0.73*	–0.38
Non-military public expenditure 80–88**	–0.07	–0.05	0.69*	0.04
Debt service/GDP 80	–0.14	–0.16	0.76*	0.03
Agriculture growth 80–88	0.16	0.24	0.26	0.18
Average GDP 80–88	0.12	0.15	0.04	0.91*
Area 88	–0.05	–0.11	–0.05	0.89*
Average population 80–88	–0.02	0.26	–0.12	0.69*
Eigen Value	**5.27**	**3.47**	**2.70**	**2.15**

Notes:
Orthogonally rotated factor matrix computed using SPSS/PC + 4.0.
Economic data from: World Bank, World Development Report, 1990, 1982 (New York: Oxford University Press).
Non-military government expenditure from the United States Arms Control and Disarmament Agency, World Military Expenditures and Arms Transfers, 1989 (Washington: USACDA, 1990).

***Average value over the 1980–88 period.*

balance of payments, as, at the margin, fuel is imported. In financial year 1988, thermal generation accounted for 57 per cent of total power generation.

Almost half the thermal generation is oil-based, due to the failure to expand the use of domestic coal and gas for thermal generation. Pricing, political and technical issues have hampered private investment in both coal-mining and coal-based power generation, while gas availability has remained below demand levels, with some consumers benefiting from subsidised prices well below those of comparable energy sources. In the coal sector, difficulties may continue, as the financial and economic viability of the main coal deposits to be used for power generation has not yet proved sufficient to attract private investment.

As a result of these developments, the growth rate of energy consumption (8.3 per cent per annum in 1984–89) has exceeded the increase in supply (7.2 per cent per annum) and the energy gap has been increasing, resulting in continued load-shedding and the need for inefficient investment in back-up oil-powered generators.

During 1987/88, both oil and gas production rose by about nine per cent, while power generation registered a more impressive growth rate of about 14 per cent. Electricity supplies remained inadequate and this was reflected mainly in unsatisfied demand of small-scale industries and of farmers for operating tube-wells. The energy policy, therefore, also stressed the progressive development of renewable sources of energy, with the emphasis on tapping alternative sources, such as solar and wind.[8]

In sum, the main issues facing the energy sector include: (a) low investment by both the public and private sectors; (b) inadequate pricing policies, which led to excessive demand for some types of energy and financial difficulties for the companies; (c) excessive use of imported oil and under-development of domestic energy resources; and (d) political and institutional issues, which have delayed the implementation of large investments (e.g. the Kalabagh Dam).

If energy has been such a binding constraint on growth, the high rates of public investment in the 1970s (together with the corresponding expansion of energy production) should have been a major factor contributing to the economy's rapid growth in the 1980s. To test this thesis, the following sections attempt to quantify the role played by energy in the country's recent economic performance.

Cross-country comparisons

To gain some sense of the relationships between energy and the economy, a sample of 104 developing countries was examined for the periods 1970–80 and 1980–88 (for some variables, 1965–90). Our initial thesis is that countries, which were capable of expanding energy production in the 1970s, should, *ceteris paribus*, have experienced relatively higher growth in output during the 1980s. Because a large number of development indices are correlated with one another, an initial factor analysis[9] was undertaken, to determine the main structural/performance trends during this period. These variables consisted largely of various measures of energy consumption, economic growth in the 1970s and 1980s, the debt situation, government expenditure and population, and overall economic size. This analysis produced four major trends (factors) (**table 1**):

1. The dominant factor consisted of various measures of growth in the 1970s. Clearly a number of variables were closely correlated with overall GDP growth, including: investment growth, imports, energy consumption and, to a lesser extent, agricultural growth.

Table 2
Developing countries: major structural and performance patterns
factor scores

	Factor 1 Growth 1970s	Factor 2 Growth 1980s	Factor 3 Public/debt expenditure	Factor 4 Size
Pakistan	–0.57	1.79	–0.71	0.21
India	–0.63	1.60	–0.79	3.67
Ethiopia	–1.33	0.47	–0.93	–0.15
Malawi	–0.10	–0.44	–0.07	–0.50
Somalia	0.50	–0.50	–0.69	–0.38
Zaire	–1.66	0.47	–0.12	0.24
Madagascar	–1.34	–0.69	0.26	–0.48
Mali	–0.20	0.25	–0.86	–0.46
Burundi	–0.15	1.08	–1.17	–0.55
Nigeria	1.56	–2.26	–0.70	0.14
Zambia	–1.61	–1.02	0.94	–1.23
Niger	0.05	–1.55	–0.41	0.17
Kenya	–0.10	0.41	0.03	–0.33
Togo	0.05	–0.67	1.84	–0.05
Central African Republic	–1.61	0.68	–1.24	–0.61
Ghana	–1.71	–0.23	–1.07	–0.51
Indonesia	1.09	0.41	0.40	0.71
Mauritania	0.09	–1.14	2.39	–0.47
Sudan	–0.74	–1.07	–1.68	0.24
Bolivia	–0.15	–2.21	–0.53	–0.26
Philippines	0.32	–0.82	–0.35	–0.31
Yemen Arab Republic	3.26	–0.69	–0.91	–0.34
Senegal	–0.74	0.17	0.22	–0.54
Dominican Republic	0.24	0.51	–0.33	–0.97
Morocco	0.20	0.64	1.10	0.08
Honduras	–0.02	–0.07	–0.02	–0.47
El Salvador	–0.35	–0.32	–1.51	–0.72
Thailand	0.64	1.71	–0.05	–0.33
Cameroon	0.30	0.97	–0.66	–0.31
Jamaica	–1.68	–0.40	2.62	–0.54
Colombia	0.20	0.22	–0.57	–0.07
Paraguay	1.05	0.62	–0.88	–0.84
Tunisia	0.99	0.11	1.06	–0.60
Turkey	0.44	1.51	0.12	–0.11
Peru	–0.75	–0.44	–0.20	0.54
Chile	–0.90	–0.22	0.37	–0.26
Syria	1.76	–0.89	–1.00	–0.52
Costa Rica	0.16	0.41	0.51	–0.75
Mexico	0.24	–0.92	0.43	1.43
Malaysia	0.67	1.11	1.81	–0.79
Brazil	0.23	–0.32	0.29	4.42
Algeria	1.42	0.06	1.69	1.01
Argentina	–0.28	–1.38	–0.53	1.13
Yugoslavia	0.40	0.33	–0.35	–0.20
Korea	1.24	2.44	0.40	–0.05
Portugal	–0.43	0.37	1.43	–0.22
Greece	–0.70	–0.08	0.37	–0.16

Note: derived from data in table 1.

Interestingly, energy consumption in the 1980s was more closely associated with the pattern of growth in the 1970s than it was with the various measures of economic expansion in the 1980s.

2. The second major trend was growth in the 1980s. This growth was suppressed somewhat by the build-up of external debt, but the loading of −0.44 was not a major factor reducing the expansion during this period. Overall growth in the 1980s appeared much less tied to agricultural expansion than it was in the 1970s.

3. The third major dimension of the data consists of several measures of debt and government expenditure.

4. Overall economic size was the final major structural pattern. Here, size was a weighted average of the average GDP and population in the 1980s, together with country area.

The factor scores (**table 2**) provide measures of the relative degree to which each country ranked on each dimension. Pakistan ranked (Factor 2 score = 1.79 [0 is the mean]) especially high, in terms of growth in the 1980s — that is, the country's performance during this period was considerably above that of other developing countries. Its growth performance in the 1970s was, however, lower than the norm.

As noted, Pakistan clearly fell into the high-growth category during the 1980s. To determine the possible role of energy in contributing to this growth, our sample of countries was further analysed, using discriminant analysis.[10] Specifically, we are interested in determining the extent to which growth in the 1980s could have been predicted, given the development of domestic energy supplies in the 1970s. For this purpose, a number of energy, growth and structural variables (**table 3**) were introduced as possible discriminating variables. The initial grouping was based on the factor scores for Factor 2 above — the growth rates in the 1980s. Those countries with a score less than zero were classed as the low-growth group of countries. Correspondingly, those countries with a Factor 2 score of zero and greater were classified in the high-growth group.

An examination of the means of these two groups provides some interesting contrasts:

1. Both groups of countries experienced roughly comparable increases in energy production after the 1973–74 energy crisis. However, the low-growth group had somewhat higher rates of energy production over the 1965–80 period as a whole. Still, energy consumption was higher in the high-growth countries (but still less than the expansion of energy production). Per capita energy consumption in 1970 was considerably higher in the low-growth countries.

Table 3
Predictors of growth performance in the 1980s

Variables in discriminant analysis

	Group mean values	
	Low-growth	**High-growth**
Energy		
Energy production 1974/79	8.1	8.2
Energy production 1965/80	13.3	10.8
Energy consumption 1965/80	6.9	7.3
Energy consumption 1974/79	4.5	6.3
Per capita energy consumption 1979	980.1	619.2
Growth		
GDP 1970/80	3.8	6.0
Investment 1970/80	3.6	6.5
Public consumption 1970/80	6.0	7.1
Private consumption 1970/80	4.0	5.9
Agriculture 1970/80	2.2	3.2
Industry 1970/80	4.0	7.1
Services 1970/80	4.7	6.5
Imports 1965/80	3.1	5.9
Exports 1965/80	4.6	5.8
Structure		
Investment/GDP 1980	20.1	24.1
Incremental capital output ratio 1970/80	3.7	0.9
Incremental capital output ratio 1965/80	0.7	1.1
Savings/GDP 1980	15.4	18.1
Exports/GDP 1980	21.2	26.3
Long-term debt service/exports 1980	16.2	11.2

Statistically significant descriminating variables

		Mean values Growth groups 1980s	
	Wilks' Lambda	**Low**	**High**
GDP growth 1970—80	0.81	3.8	6.0
Investment growth 1970–80	0.74	3.5	6.5
Energy production 1965–80	0.64	13.3	10.8
Energy consumption per capita 1979	0.56	908.2	619.2
Long-term debt service/exports 1980	0.52	16.2	11.2
Industrial growth 1970–80	0.50	4.0	7.1

Notes: Based on stepwise discriminant analysis, using SPSS/PC+ 4.0.
Economic data from: World Bank, World Development Report, 1990, 1982 (New York: Oxford University Press).
Non-military government expenditure from the United States Arms Control and Disarmament Agency, World Military Expenditures and Arms Transfers, 1989 (Washington: USACDA, 1990).

2. As one might imagine, the countries achieving above-average growth in the 1980s also had superior growth performance in the previous decade. This was especially the case for investment (6.5 versus 3.6 per cent annual average growth during the 1970s) and industrial growth (7.1 versus 4.0).

3. The high-growth countries also had higher shares (of GDP in 1980) of investment and savings, together with lower debt burdens at the beginning of the 1980s.

Of these variables, six were found to be statistically significant in splitting the total sample into two groups: (a) GDP and investment growth in the 1980s were the most important; followed by (b) energy production in 1965–80; (c) energy-consumption per capita in 1979; (d) long-term debt service to exports in 1980; and (e) the growth of industrial production in the 1970s.

An examination of the corresponding discriminant scores and probability of group classification (**table 4**) indicates that these six variables predicted growth in the 1980s with a high degree of accuracy. In terms of their actual performance in the 1980s, only three countries — India, The Philippines and El Salvador — were incorrectly grouped. Pakistan's growth performance was predicted with a probability of 92 per cent.

To summarise: from the perspective of 1980, it appears to be possible to have predicted the overall economic performance of developing countries in the 1980s with a high degree of accuracy. For the purposes of this study, however, national efforts toward increasing energy production do not appear to have been a critical element in separating high from low-growth countries. The high-growth countries of the 1980s do not appear to have made a special effort in the 1970s to increase their energy capacity.

To test this finding, a further series of multiple regressions was performed on the total sample of countries and on several sub-groupings. The growth model estimated had the form:

$$GDP = f[I, I - 1, EP - 1, EP]$$

where:

GDP = the growth in GDP, 1980–88
I = the growth in investment, 1980–88
I – 1 = the growth in investment, 1970–80
EP – 1 = the growth in energy production, 1965–80
EP = the growth in energy production, 1980–88

That is, after controlling for the major sources of growth, investment and lagged investment[11] tests were performed, to assess the possible impact of energy production on overall economic growth in the 1980s.

Table 4
Developing countries: factors predicting economic performance in the 1980s

	Discriminant score	Group probability Low growth	High growth
Pakistan	–1.23	0.08	0.92
India	0.05	0.51*	0.49
Ethiopia	0.21	0.59	0.41
Tanzania	–2.22	0.01	0.99
Malawi	–1.36	0.06	0.94
Madagascar	1.63	0.96	0.04
Mali	0.64	0.77	0.23
Uganda	–0.89	0.14	0.86
Nigeria	0.02	0.49	0.51
Zambia	2.66	0.99	0.01
Kenya	–1.99	0.02	0.98
Central African Republic	–1.99	0.02	0.98
Ghana	2.18	0.99	0.01
Sri Lanka	0.48	0.71	0.29
Indonesia	–1.13	0.09	0.91
Sudan	0.48	0.71	0.29
Burma	0.35	0.66	0.34
Bolivia	2.22	0.99	0.01
Philippines	–0.86	0.15*	0.85
Egypt	–0.66	0.20	0.79
Ivory Coast	0.36	0.66	0.34
Dominican Republic	–0.51	0.26	0.74
Morocco	–0.41	0.30	0.70
Honduras	1.73	0.97	0.03
Guatemala	–0.75	0.18	0.82
Congo	3.32	0.99	0.01
El Salvador	–0.19	0.40*	0.60
Thailand	–2.13	0.01	0.99
Cameroon	–0.18	0.40	0.60
Jamaica	1.63	0.96	0.04
Ecuador	–0.43	0.29	0.71
Colombia	–2.23	0.01	0.99
Tunisia	–0.64	0.21	0.79
Turkey	–0.77	0.17	0.83
Peru	1.55	0.95	0.05
Chile	0.33	0.64	0.36
Syria	1.14	0.90	0.10
Costa Rica	–0.02	0.48	0.52
Mexico	1.36	0.93	0.07
Malaysia	–1.52	0.05	0.95
Panama	–0.54	0.25	0.75
Brazil	1.40	0.94	0.06
Nicaragua	2.34	0.99	0.01
Algeria	–0.69	0.20	0.80
Argentina	2.13	0.98	0.02
Yugoslavia	–0.58	0.23	0.77
Korea	–2.07	0.02	0.98
Portugal	–0.91	0.14	0.86
Greece	0.03	0.51	0.49

Notes: Based on stepwise discriminant analysis, using SPSS/PC+ 4.0.
Economic data from: World Bank, World Development Report, 1990, 1982 (New York: Oxford University Press).
Non-military government expenditure from the United States Arms Control and Disarmament Agency, World Military Expenditures and Arms Transfers, 1989 (Washington: USACDA, 1990).
**Incorrect prediction.*

For the sample as a whole (**table 5**):

1. Investment during 1980–88 accounted for slightly more than 47 per cent of the observed variation in developing country growth rates during that period. However, investment during the 1970s did not significantly accelerate growth performance in the next decade.

2. Energy production in the 1970s did not contribute to growth in the 1980s. However, energy production in the 1980s was statistically significant in expanding growth.

3. Pakistan grew at an annual average rate of 6.5 per cent per annum during 1980–88. The estimated model, however, anticipated that the country would have grown at a rate of 4.3 per cent.

Dropping the countries with very poor growth performance in the 1980s (those with a Factor 2 score of –1.5 or less, **table 6**) resulted in lagged investment now becoming significant. On the other hand, energy production in the 1980s was no longer statistically significant in contributing to growth in the 1980s.

Lagged investment continued to be strengthened and energy production lessened in their contribution to growth in the 1980s, as more and more lower-growth countries were dropped from the sample (**tables 7** and **8**).

Finally, by the time only the high-growth group of countries was left in the sample — countries with a Factor 2 score of more than zero (**table 9**):

1. Both current and lagged investment were about equally important in contributing to growth in the 1980s. That is, countries that grew above the norm in the 1980s were those able to maintain fairly high rates of investment over the period 1970–88.

2. Energy production does not appear to have contributed to above-normal economic performance in the 1980s. That is, countries, which increased their energy production relative to other countries, did not have corresponding growth rates to show for this effort.

3. When examined in the context of high-growth countries, investment (current plus past) explained only about one-third of Pakistan's growth during 1980–88. That is, as Pakistan was examined in the context of a group of countries comprising an increasing proportion of high-growth countries, the percentage of its growth explained by investment declined.

This final point lends support to the argument that much of Pakistan's growth in the 1980s simply reflects the depletion of capital stock, rather than the increased efficiency of existing capital.

Table 5
Developing countries: sources of growth, 1980–88
standardised regression coefficients

Total country sample

(1) GDP = 0.69 I(80/88)
(7.20)***

df = 57; R^2(adj) = 0.476; F = 51.81

(2) GDP = 0.69 I(80/88) + 0.17 I(70/80)
(7.23)*** (1.78)*

df = 56; R^2(adj) = 0.486; F = 28.48

(3) GDP = 0.70 I(80/88) + 0.16 I(70/80) + 0.06 EP(65/80)
(7.30)*** (0.16)* (0.52)

df = 55; R^2(adj) = 0.481; F = 18.93

(4) GDP = 0.64 I(80/88) + 0.09 I(70/80) + 0.06 EP(65/80) + 0.24 EP(80/88)
(6.82)*** (1.04) (0.66) (2.51)**

df = 54; R^2(adj) = 0.526; F = 17.19

Actual versus predicted growth rates

	Actual	Predicted
Pakistan	6.5	4.3
India	5.2	3.8

Notes for tables on pages 160–162

1. Applicable to tables 5–9:
df = degrees of freedom; R^2(adj) = adjusted coefficient of determination; F = F statistic; ( ) = t statistic. GDP = average annual growth in gross domestic product, 1980–88; I(80/88) average annual growth in investment 1980/88; EP(65/80) = average annual growth in energy production 1965–80; EP(80/88) = average annual increase in energy production 1980–88.

**Significant at the 90 per cent level of confidence.*
***Significant at the 95 per cent level of confidence.*
****Significant at the 99 per cent level of confidence.*
Actual and predicted values computed from equation (4).

2. Applicable to tables 6–9:
Factor 2 score based on data in table 1

Table 6
Developing countries: sources of growth, 1980–88
standardised regression coefficients

Countries with Factor 2 > –1.5

(1) $\underset{(4.65)^{***}}{\text{GDP} = 0.61\ \text{I}(80/88)}$

df = 36; R^2(adj) = 0.358; F = 21.59

(2) $\text{GDP} = \underset{(5.14)^{***}}{0.61\ \text{I}(80/88)} + \underset{(2.91)^{**}}{0.34\ \text{I}(70/80)}$

df = 35; R^2(adj) = 0.468; F = 17.30

(3) $\text{GDP} = \underset{(4.99)^{***}}{0.61\ \text{I}(80/88)} + \underset{(2.88)^{**}}{0.36\ \text{I}(70/80)} - \underset{(-0.30)}{0.04\ \text{EP}(65/80)}$

df = 34; R^2(adj) = 0.454; F = 11.26

(4) $\text{GDP} = \underset{(4.66)^{***}}{0.57\ \text{I}(80/88)} + \underset{(2.43)^{**}}{0.30\ \text{I}(70/80)} - \underset{(-0.30)}{0.03\ \text{EP}(65/80)} + \underset{(1.43)}{0.18\ \text{EP}(80/88)}$

df = 33; R^2(adj) = 0.528; F = 9.23

Actual versus predicted growth rates

	Actual	**Predicted**
Pakistan	6.5	4.2
India	5.2	3.9

Table 7
Developing countries: sources of growth, 1980–88
standardised regression coefficients

Countries with Factor 2 > –1.0

(1) $\underset{(4.14)^{***}}{\text{GDP} = 0.58\ \text{I}(80/88)}$

df = 33; R^2(adj) = 0.321; F = 17.12

(2) $\text{GDP} = \underset{(4.87)^{***}}{0.62\ \text{I}(80/88)} + \underset{(2.85)^{**}}{0.36\ \text{I}(70/80)}$

df = 32; R^2(adj) = 0.442; F = 14.49

(3) $\text{GDP} = \underset{(4.68)^{***}}{0.61\ \text{I}(80/88)} + \underset{(2.88)^{**}}{0.39\ \text{I}(70/80)} - \underset{(-0.61)}{0.08\ \text{EP}(65/80)}$

df = 31; R^2(adj) = 0.431; F = 9.60

(4) $\text{GDP} = \underset{(4.46)^{***}}{0.58\ \text{I}(80/88)} + \underset{(2.48)^{**}}{0.34\ \text{I}(70/80)} + \underset{(-0.60)}{0.08\ \text{EP}(65/80)} + \underset{(1.46)}{0.19\ \text{EP}(80/88)}$

df = 30; R^2(adj) = 0.450; F = 8.00

Actual versus predicted growth rates

	Actual	**Predicted**
Pakistan	6.5	2.2
India	5.2	1.3

Table 8
Developing countries: sources of growth, 1980–88
standardised regression coefficients

Countries with Factor 2 > –0.5

(1) GDP = 0.51 I(80/88)
(3.14)**

df = 38; R^2(adj) = 0.234; F = 9.92

(2) GDP = 0.50 I(80/88) + 0.49 I(70/80)
(3.71)*** (3.61)**

df = 27; R^2(adj) = 0.465; F = 13.63

(3) GDP = 0.52 I(80/88) + 0.48 I(70/80) + 0.08 EP(65/80)
(3.71)*** (3.46)** (0.55)

df = 26; R^2(adj) = 0.451; F = 8.95

(4) GDP = 0.47 I(80/88) + 0.43 I(70/80) + 0.05 EP(65/80) + 0.22 EP(80/88)
(3.40)*** (3.03)** (0.36) (1.53)

df = 25; R^2(adj) = 0.478; F = 7.64

Actual versus predicted growth rates

	Actual	Predicted
Pakistan	6.5	2.3
India	5.2	1.3

Table 9
Developing countries: sources of growth, 1980–88
standardised regression coefficients

Countries with Factor 2 > 0

(1) GDP = 0.46 I(80/88)
(2.34)**

df = 19; R^2(adj) = 0.218; F = 5.32

(2) GDP = 0.54 I(80/88) + 0.53 I(70/80)
(3.19)** (3.14)**

df = 18; R^2(adj) = 0.439; F = 8.82

(3) GDP = 0.56 I(80/88) + 0.53 I(70/80) + 0.04 EP(65/80)
(3.15)*** (3.06)** (0.51)

df = 17; R^2(adj) = 0.503; F = 5.73

(4) GDP = 0.50 I(80/88) + 0.50 I(70/80) + 0.04 EP(65/80) + 0.22 EP(80/88)
(2.76)*** (2.89)** (0.23) (1.23)

df = 16; R^2(adj) = 0.431; F = 4.80

Actual versus predicted growth rates

	Actual	Predicted
Pakistan	6.5	2.2
India	5.2	1.1

In sum, comparative data does not provide much support for the idea that energy production (and presumably investment in energy) necessarily creates expanded rates of growth. This is not to say, however, that some sectors may benefit appreciably from increased domestic sources of energy, but rather that the economy as a whole is better served by expanded capital formation in other areas.

The impact of energy investment over time

A critical question, that must ultimately be addressed, concerns the direction of causation: has investment in energy in Pakistan affected various aspects of the national economy or has energy investment simply responded to the needs generated by the rapid rate of economic expansion over the last few decades? In other words, before drawing any definitive conclusions as to the impact of the government's large investment in energy-producing capacity, one must satisfactorily address the issue of causation. Fortunately, several statistical tests using regression analysis for this purpose are gaining wider acceptance. The original and most widely used causality test was developed by Granger.[12] According to this test, energy causes growth in GDP if growth can be predicted more accurately by past values of energy investment than by past values of growth. To be certain that causality runs from energy to growth, past values of energy must also be more accurate than past values of growth at predicting energy expenditure.

More formally, four cases are possible:

(a) energy causes growth, when the prediction error for growth decreases when energy investment is included in the growth equation. In addition, when growth is added to the energy equation, the final prediction error should increase;

(b) growth causes energy, when the prediction error for growth increases when energy is added to the regression equation for growth, and is reduced when growth is added to the regression equation for energy;

(c) feedback occurs, when the final prediction error decreases when defence is added to the growth equation, and the final prediction error decreases when growth is added to the defence equation; and

(d) no relationship exists, when the final prediction error increases both when defence is added to the growth equation and when growth is added to the energy equation.

Operational procedures

The data for investment in energy used to carry out the causation tests were derived from those provided by the World Bank and International Monetary Fund.[13] For the best statistical results,[14] the variables were transformed into their

Table 10
Pakistan: interaction of capital formation in energy and the economy, 1972–90

Optimal lag *(years)* Final prediction error ( )	Causation patterns A	B	C	D	Dominant pattern
Gross domestic product					
Energy	2	2	4	1	
Investment	(0.29E-3)	(0.30E-3)	(0.88E-1)	(0.74E-1)	GDP → Energy(+w)
Energy	2	1	4	1	
Infrastructure	(0.29E-3)	(0.33E-3)	(0.81E-1)	(0.70E-1)	GDP → Energy(+w)
Private investment					
Energy	3	4	4	1	
Investment	(0.26E-2)	(0.19E-2)	(0.89E-1)	(0.77E-1)	Feedback(+m,+w)
Energy	3	3	4	1	
Infrastructure	(0.26E-2)	(0.15E-2)	(0.81E-1)	(0.73E-1)	Feedback(+m,+w)
Total investment					
Energy	3	4	4	2	
Investment	(0.24E-1)	(0.87E-2)	(0.88E-1)	(0.59E-1)	Feedback(+m,+w)
Energy	3	4	4	4	
Infrastructure	(0.24E-1)	(0.20E-1)	(0.81E-1)	(0.67E-1)	Feedback(+m,+w)

Notes: Summary of results obtained from Granger Causality Tests. A Hsaio Procedure was incorporated to determine the optimal lag. Regression patterns: A = private on private; B = public on private; C = public on public; D = private on public. The dominant pattern is that with the lowest final prediction error. The signs (+,–) represent the direction of impact. In the case of feedback, the two signs represent the lowest final prediction error of relationships B and D. Each of the variables was regressed with 1, 2, 3 and 4-year lags. Strength assessment (s = strong; m = moderate; w = weak) based on the size of the standardised regression coefficient and t-test of statistical significance.

annual rate of growth. Unfortunately, the government of Pakistan does not publish data on the stock of, and increments to, the country's energy infrastructure. However, following the procedure of Blejer and Khan,[15] it is possible to approximate increments to the nation's energy infrastructural base. The basic assumption underlying these proxies is that infrastructure investment is an on-going process, which moves slowly over time and cannot be changed very rapidly.

The first of the two approaches takes the trend level of real public sector investment as representing the long-term, or infrastructural, component. A second approach is to make the distinction between types of public investment, on the basis of whether the investment is expected. Again, it is assumed that expected (anticipated) public investment is closer to the long-term, or infrastructural, component. If deterioration is occurring in the country's stock of infrastructure, this measure may be a more accurate proxy than that obtained using the trend method. It is the measure adopted in the analysis below.

Relationships between energy expenditure and the economy were considered valid if they were statistically significant at the 95 per cent level of confidence. That is, if 95 per cent of the time we could conclude that they had not occurred by pure chance, we considered them statistically significant.

Finally, there is no theoretical reason to believe that the links between infrastructure and the economy have a set lag relationship — that is, they impact on one another over a fixed time period. The period could be short-run, involving largely the spin-off from construction, or longer-term, as either term expands from the stimulus provided by the other. To find the optimal adjustment period of impact, lag structures of up to six years were estimated. The lag structure with the highest level of statistical significance was the one chosen to best depict the relationship under consideration (the optimal lag reported in tables 9 and 10).

Results

The results for gross domestic product, and private and total investment (**table 10**) indicate the direction of causation, together with the optimal lag time. Strength assessments reflect the magnitude of the impact (in terms of constant price, local currency units) and the statistical significance of the relationship. Several patterns are of interest.

1. Energy investment (and infrastructure) have responded to the needs created by expanded GDP, rather than stimulating or initiating increases in growth. In addition, despite the fairly rapid increase in energy investment in recent years, this response has been rather weak.

2. Energy investment and infrastructure are much more closely related to private investment than growth. In general, energy provides a fairly strong stimulus to private investment (over a four-year period). In turn, private investment provides a weak stimulus (with a year lag) to expanded energy production. That is, the government seems to respond fairly weakly, but quickly, to the needs created by expanded private investment.

3. Generally, the same patterns for private investment hold for total (private plus public) investment. However, the feedback lags from investment to energy investment are slightly longer than those associated with private investment.

Conclusion

While not denying the importance of investment in the energy sector in Pakistan, the above analysis casts doubt on the argument that, in the period up to 1990, energy had been a major factor constraining the expansion of the Pakistani economy. There is little evidence that the overall economic growth of the country had been stimulated by the expansion in energy that took place during the previous decade and a half. However, this pattern may be changing. Pasha's[16] findings suggest that, towards the end of the 1980s, power outages reduced GDP by about 1.8 per cent. If true, this fact, together with the finding of a positive linkage from energy to private investment, is sufficient to justify accelerating the country's investment in energy capacity. This conclusion is reinforced by the government's shift in recent years towards relying on private investment (as opposed to public investment) as a major source of economic growth.[17]

Footnotes

1. *Laumas, P.S., and M. Williams, "Energy and Development", Weltwirtschaftliches Archiv (1981), p. 706.*

2. *Described in Hafiz A. Pasha, Aisha Ghaus and Salman Makik, "The Economic Cost of Power Outages in the Industrial Sector of Pakistan", Energy Economics (1989), p. 301.*

3. *Charles K. Ebinger, Pakistan: Energy Planning in a Strategic Vortex (Bloomington, Indiana: Indiana University Press, 1981), p. 4.*

4. *Pasha, Hafiz A., Aisha Ghaus and Salman Malik, "The Economic Cost of Power Outages in the Industrial Sector of Pakistan", Energy Economics (1989), pp. 301–318.*

5. *World Bank, World Development Report, 1990 (New York: Oxford University Press, 1990), p. 186.*

6. *United Nations Economic and Social Commission for Asia and the Pacific, Economic and Social Survey of Asia and the Pacific, 1988 (Bangkok: United Nations, 1989), p. 33.*

7. *United Nations Economic and Social Commission for Asia and the Pacific, Economic and Social Survey of Asia and the Pacific, 1988 (Bangkok: United Nations, 1989), p. 34.*

8. *United Nations Economic and Social Commission for Asia and the Pacific, Economic and Social Survey of Asia and the Pacific, 1988 (Bangkok, United Nations, 1989), p. 34.*

9. *The analysis was undertaken using the SPSS statistical package. A full documentation of the technique and interpretation of results is given in: SPSS/PC+ Statistics version 4.0 (Chicago: Marija J. Norusis/SPSS Inc, 1990).*

10. *For a description and documentation of this procedure, see SPSS/PC+ version 4.0, Advanced Statistics (Chicago: Marija J. Norusis/SPSS Inc, 1990), pp. B1–B38.*

11. *Several studies have shown that, once growth momentum has been built up, it tends to continue from decade to decade. See, for example, J.Nugent, "Momentum for Development and Development Disequilibria", Journal of Economic Development (July 1977), pp. 31–52; and Robert E. Looney and P.C. Frederiksen, "The Iranian Economy in the 1970s: Examination of the Nugent Thesis", Middle Eastern Studies (October 1988), pp. 490–494.*

12. *C.W.J. Granger, "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods", Econometrica (1969), pp. 424–438.*

13. *World Bank, Pakistan: Current Economic Situation and Prospects, Report No. 9283PAK (22 March 1991); World Bank, Pakistan: Progress Under the Sixth Plan (1984). Gross domestic product and the GDP price deflator are from various issues of the International Monetary Fund, International Financial Statistics Yearbook. All variables were deflated by the GDP deflator and are in constant 1985 prices.*

14. *The underlying reasons involve the assumption of stationary conditions. See C. Hsiao, "Autoregressive Modeling and Money-Income Causality Detection", Journal of Monetary Economics (1981), pp. 85–106, and W. Joerding, "Economic Growth and Defence Spending: Granger Causality", Journal of Development Economics (1986), pp. 35–40.*

15. *Blejer, Mario I., and Mohsin S. Khan, "Public Investment and Crowding Out in The Caribbean Basin Countries", in Michael Connolly and John McDermott, The Economics of the Caribbean Basin (New York: Praeger Publishers, 1985), pp. 219–236.*

16. *Pasha et al, op cit.*

17. *Cf Robert Looney, "An Assessment of Pakistan's Attempts at Economic Reform", Journal of South Asian and Middle Eastern Studies, volume XV, no. 3 (Spring 1992), pp. 1–28.*